Sudden Oak Death (SOD) Survey

In

New Jersey's Woodlands

(2004 - Year 1)

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Prepared by:

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New Jersey Forest Service
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http://www.nj.gov/dep/parksandforests/forest/njfs_forest_health.html

In cooperation with:

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Abstract

Sudden oak death (SOD) is a disease caused by the pathogen *Phytophthora ramorum* and was first reported in central coastal California in 1995 (USDA Pest Alert NA-PR-02-02). Once infected, certain oak tree species can die within a few months to a few years. California nurseries that had contaminated stock or the potential for contamination were quarantined so as not to distribute material to other parts of the country. However, prior to quarantine, plant material particularly Camellia (*Camellia* spp.) was shipped to NJ garden centers and nurseries and other states in 2003. As a result of host plant material entering NJ, the NJ Forest Service applied for and received a federal grant in order to perform a survey of the recipient nursery's respective woodland perimeter(s). The survey was performed in June through early July 2004 and proceeded from Cape May to Bergen County. Suspect samples were collected and shipped to laboratories via overnight delivery. This process would maintain sample integrity for diagnostic analysis. All samples submitted tested negative for *P. ramorum.* Woodland areas selected were based on the presence of an enoculum factory consisting of host understory species and the presence of oak in the overstory.

Introduction

In order to perform the Sudden oak death (SOD) survey essential training was required for *P. ramorum* biology, site location, sampling design and intensity, host species ID, sample collection and preservation, chain of custody, and GPS location of transects or points. This training was provided by a USFS pathologist and the USFS, NE Forest Health Program Coordinator in Brendan T. Byrne State Forest and the State Forest Tree Nursery on June 2, 2004. Training was attended by eight-(8) NJFS foresters and a representative from the NJ Department of Agriculture. Training duration was one- (1) day and was structured into classroom and field exercises. In addition, a national training via conference call and PowerPoint presentation, *Phytophthora ramorum*: Educate to Detect (PRED) was given in October 2004 where many western and eastern states attended. This training was provided and organized by the USDA-Forest Service, USDA-Cooperative State Research Education & Extension Service, IPM Regional Centers, National Plant Diagnostic Network, and USDA-Animal and Plant Health Inspection Service (APHIS).

Technical Information

SOD poses a serious threat to the Nation's oak forest types, urban forests and horticultural industries. "In California, it has affected ecosystem functions, increased fire and safety hazards, and reduced property values in developed areas" (USDA Forest Service). The advanced stages of SOD result in high levels of mortality of tanoak, coast live oak, California black oak in woodlands or within the wildland-urban interface (Garbelotto, Rizzo, Davidson, Frankel). To date, tens of thousands of trees have died on the west coast and management operations to "slow-the-spread" are underway. Currently cutting and burning of host plants has shown to eradicate the disease. At this time, only oaks in the black and red oak groups are known to be susceptible to *P. ramorum.* Tree Species in NJ at risk are Northern red oak (*Quercus rubra),* which is the NJ State Tree, Southern red oak (*Q. falcata),* black oak (*Q. velutina*) and scarlet oak (*Q. coccinea*).

Northern red oak is a significant component within hardwood forest types across northern NJ including the Highlands, Piedmont and Hudson Ridge and Valley Regions. Southern red and scarlet oaks are common components of forest stands along the Delaware basin and southern coastal plain. USFS Forest Inventory and Analysis (FIA), 1999 data indicates that Northern and Southern red oak, scarlet oak and black oak occur in over 1.2 million acres in NJ. Common understory species including mountain laurel and *Viburnum* spp. are also at high risk.

The following photo depicts how SOD is occurring on coast live oak the Wildland-Urban Interface (WUI) in California.

Photo 1.

Photo courtesy of Marin County Fire Department, May 2000. The disease results in discoloration (brown to gray) and high mortality.

Biology and Symptoms

Phytophthora species are fungi that cause plant disease in the soil (root rots), above ground on stems (cankers), leaf spots and petioles. A major problem has developed in parts of California and Oregon where thousands of coast live oak (*Quercus agrifolia*), tanoak (*Lithocarpus densiflorus*), Shreve's oak (*Quercus parvula*) and California black oak (*Quercus kelloggii*) have died or are presently declining. Sudden Oak Death (SOD), a disease caused by the fungus *Phytophthora ramorum*, is directly implicated. The fungus initially infects the understory species California bay laurel (*Umbellularia californica*). This host provides suitable plant material that enables the fungus to produce a plethora of infectious aerial spores that can be carried by wind or rain to the above mentioned tree species.
The pathogen can be spread by the following ways:

- Sporangia spores – spread by wind and driving rain
- Clamydospores – spread by physical means i.e., machinery, people and are persistent in the environment for 1-2 years in the soil
- Zoospores (originate from sporangia) – are motile (flagellate) and may be transported by water moisture on plant surfaces

The infectious fungal spores germinate into wood cracks or wounds and develop into structures called hyphae that invade and destroy the tree stem phloem and outer xylem. Eventually diseased areas called cankers are formed. Cankers coalesce effectively girdling the tree stem, disrupting water and nutrient transport that eventually causes tree mortality. Cankers on the bark are the primary symptoms for identifying *P. ramorum* and usually develop 1 to 2 meters off the ground but have occurred up to 25 meters upwards on stems in tanoak (Davidson, Werres, Garbelotto, Hansen, Rizzo). In California, the colonization of California bay laurel by *P. ramorum* is essential for the spread of the fungus onto oak species and has been described as an "enoculum factory" producing increasing numbers of infectious spores thereby directly increasing the rapid spread of the disease. A similar situation with SOD exits in Europe where European beech (*Fagus sylvatica*) and English oak (*Quercus rubur*) have become infected but only when associated with naturally occurring understory rhododendrons (*R. ponticum*) and viburnums (*V. tinus*).

From the above it is assumed that a similar situation may potentially occur in the northeastern US within forest areas where various oak species and rhododendron and viburnum understory species occur together. Experimentally eastern red oak and pin oak seedlings have been successfully inoculated with *P. ramorum.* Therefore, a potential for the development of new disease areas exists here in our eastern states. Exacerbating this potential is the fact that thousands of ornamental plants over the last several years have been shipped from nurseries in California to nurseries throughout the eastern US. It has been determined by APHIS that some of these plants shipped were inadvertently infected with the SOD pathogen. Although plant shipments are being continuously monitored, many plants sold in past years may presently exist as house plants throughout the east. These rouge plants potentially are able to create a new disease epidemic within the eastern US. Monitoring eastern

understory species as well as oak stems for cankers is necessary and crucial at this time to determine initial infection loci or centers if they should occur thus enabling timely control of the disease (Iskra, 2005). Control measures can include quarantining an area, harvesting, burying or burning infected material and then monitoring the area of concern for a period of 2-years for *P. ramorum*.

Photo 2 to the right shows a bleeding canker associated with *P. ramorum* infection. Canker size can range from an inch to several feet. During later stages of infection, the bark may split. Several cankers on a single stem may eventually girdle and kill the tree.

Photo 2. Courtesy USDA Forest Service

Due to canker development, crowns rapidly deteriorate (tan oak) and leaves turn chlorotic and wilt.

Photo 3.

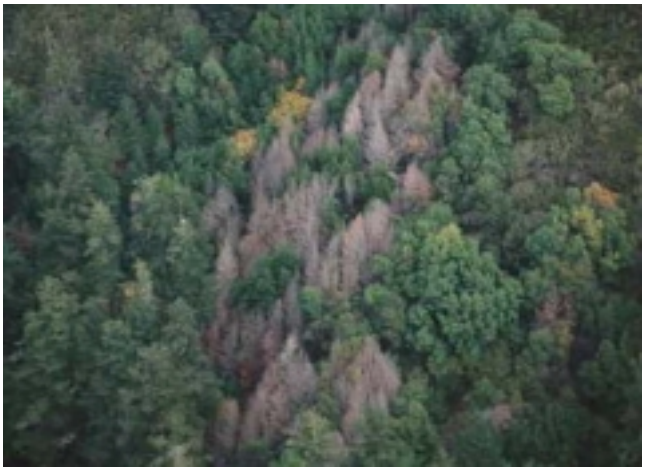
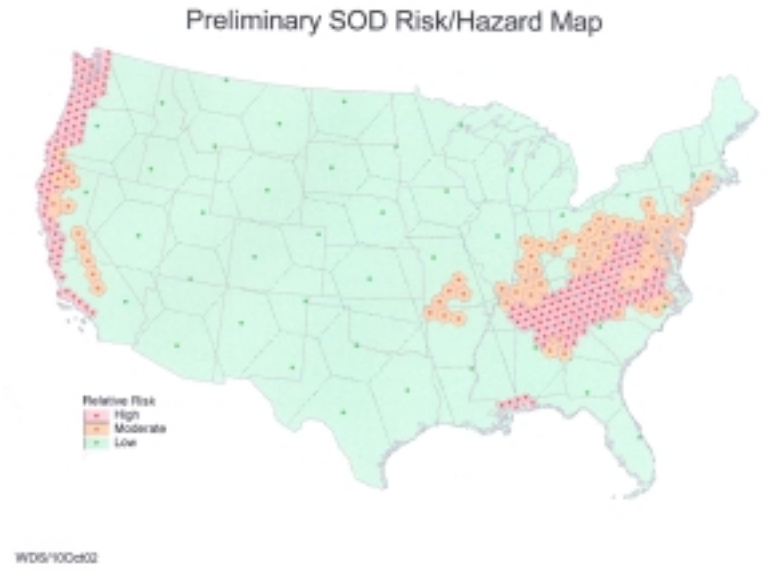


Photo 3 (left) is an example of mortality to tanoak in the woodland environment of California. Courtesy of the Marin County Fire Department, 2000.

Methodology

The NJ Forest Service used the US Department of Agriculture, APHIS PPQ: 2004 Survey Manual as guidance in performing the SOD Survey in NJ. This manual provided biological aspects of the disease, host species information, and survey and sampling protocols. Prior to commencing a survey for the detection of SOD certain data must be known in order to select the correct sites. To accomplish this, the National SOD Risk Map (Figure 1.) was used to detect where *P. ramorum* would most likely occur in NJ. This map is based on climatic factors and the likelihood of mortality occurring. These host species would need to occur in the over and understory stratum. The Risk Maps indicates that NJ has a moderate risk of infection and that the most probable areas for occurrence would be the northeastern and southern areas of the State. These areas have a high occurrence of over and understory species needed for the enoculum factory and are associated with *P. ramorum* i.e., red oak group tree species, mountain laurel (*Kalmia latifolia*), and *Viburnum* spp. Other vegetative species that are present but have been challenged with *P. ramorum* and are designated as low risk plants are flowering dogwood (*Cornus florida*),

holly (*Ilex* spp.), mulberry (*Morus* sp.), and grapevine (*Vitis vinifera*) (USDA, APHIS PPQ: *Phytophthora ramorum* Low Risk Plants, April 2004).



The figure to the left depicts the areas within the United States that are at risk to *P. ramorum*. Each Although the north and central western sections of NJ are not falling within the risk areas, these areas could still be at risk due to nurseries and garden centers receiving containerized stock from the western U.S.

Figure 1. Courtesy of the USDA, Forest Service.

Another critical piece of information is what nurseries or garden centers in NJ received host species from (the quarantined zone of) the west coast. The NJFS contacted the NJ Department of Agriculture, Division of Plant Industry in order to acquire a potential list of these nurseries. Plant Industry provided a list of the 29 nurseries they surveyed for *P. ramorum* due to stock received from the quarantine zone and the NJFS selected 10 of those nurseries for our woodland survey. Prior to on-site surveys, extensive aerial photographic interpretation was performed in order to further refine the survey and sampling process. This was performed plotting the nurseries coordinates against 1995 & 2002 Color Infrared (CIR) photography via Geographical Information System (GIS) software. Forest types and theoretical transects where then determined. The likely occurrence of understory species was based upon overstory – understory relationships, soils, topographical features and regional site familiarities. If a site did not meet the most probable conditions present for *P. ramorum* i.e., no oak or associated enoculum factory species or highly developed area (sub/urban) with no local forest or woodland perimeter, another location would be 'processed'. Site selection was biased in order to sample the most probable sites for *P. ramorum* presence. After a site (nursery) passed this process landowners were contacted and permission was requested to access the property. In only two cases was permission not granted to access property and the process was repeated until 10 sites were surveyed.

Once on the property, contact with a property representative was made and on-site reconnaissance began for the establishment of up to four –(4) woodland transects each totaling 100 meters. These transects would be parallel the nursery perimeter and progress through the enoculum factory. See Map 2. If a woodland perimeter was not present or ground reconnaissance resulted in no enoculum factory, another wooded area was selected. In two cases a nearby alternate location was established and transects were modified to have transects radiating from central point in four cardinal directions. See Map 3.

After transect establishment, beginning and end points where located via Geographical Positioning Systems (GPS) for future reference. The transect was walked while collecting samples that appeared to have symptoms of *P. ramorum.* Samples were recorded on tally sheets indicating site location, transect number, species, sample type i.e., leaf, twig or bark and laboratory where the samples were to have diagnostics performed. The samples where then placed in separate plastic storage bags by species and transect with a chain of custody form and into a cooler with an ice pack.

Having a forest pathologist during 70 percent of the survey was extremely beneficial in sampling process. While some samples evaluated were ruled-out as possible *P. ramorum* due to other disease characteristics, many were collected because DNA testing needed to be performed for confirmation.
The following two photos are an example of SOD on host material and anything resembling this was collected for diagnostics.

Photo 4. Witch Hazel (*Hamamelis virginiana*)

Photo 5. Mountain Laurel (*Kalmia latifolia*)

Photo 4. Courtesy of Margaret O'Donnell, Department for Environment, Food and Rural Affairs (DEFRA)
Photo 5. Photo courtesy of Steve Ashby, Department for Environment Food and Rural Affairs; York, UK

In order to preserve sample integrity, ice packs where monitored and replaced (as needed) for two to three days during storage. Fresh ice packs were used immediately prior to shipment. All coolers were shipped Priority Overnight Delivery to the corresponding lab - Maryland Dept of Agriculture and Mississippi State University (MSU). MSU was designated for quality control. Once received, lab personnel placed the samples in freezers and returned the coolers with ice packs. Approximately 12 coolers where used in order to keep this cycle uninterrupted.

Results and Discussion

The 2004 SOD Survey resulted in the collection of 55 individual sample bags collected and analyzed. DNA testing was the preferred method used to determine the presence or absence of *P. ramorum* with all samples testing NEGATIVE. These diagnostic results were expected but not without concern that *P. ramorum* could be present and pose a threat to NJ's forests. Table 1 below is a breakdown of the survey performed on the 10 site locations.

Table 1

Transect and Sample Collection Summary for 2004 (Year 1) NJ SOD Survey

Site	County	# of Transects	# of Samples*	# of Species	Type of Sample
1	Cape May	3	5	3	Leaf
2	Cape May	4	5	2	Leaf
3	Burlington	4	6	2	Leaf, Twig
4	Cumberland	3	4	3	Leaf
5	Ocean	4	10	2	Leaf, Twig
6	Middlesex	4	6	3	Leaf
7	Morris	4	5	3	Leaf, Bark
8	Bergen	4	2	1	Leaf
9	Ocean	4	7	3	Leaf
10	Monmouth	4	4	3	Leaf

* One bark sample was collected off-site (transect) for diagnostic analysis and is not represented here.

Turn-around time for sample diagnostics was a few weeks to a couple or months depending upon lab and amount of samples the lab needed to process from other states involved in the National SOD Survey. Samples arrived in sufficient time and good quality that allowed the diagnostics to be performed accurately.

Recommendations

The NJFS will perform a SOD Survey of 10 nursery and/or garden centers in June 2005. These sites will be different locations from the previous year with the premise that if *P. ramorum* is detected by the NJ Department of Agriculture, Division of Plant Industry survey, site(s) will be changed to survey those woodland perimeters regardless if those locations were surveyed previously. This will allow significant coverage in sampling for the disease. The NJ Forest Service will continue to collaborate survey efforts with the US Forest Service – Forest Health Program.

It is also recommended that a NJ SOD Task Force be initiated that would involve interagency and academic professionals for monitoring. This task force would be essential should containment, eradication and restoration be necessary. Resource professionals would include but not be limited to the NJ Forest Service, NJ Dept. of Agriculture, APHIS Plant Protection and Quarantine (PPQ), Rutgers University, Master Gardeners, and private conservation groups.

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